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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/615,915	07/10/2003	Yohei Yamazawa	227430US26	9540

22850 7590 01/14/2008

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EXAMINER	
DHINGRA, RAKESH KUMAR	
ART UNIT	**PAPER NUMBER**
1792	

NOTIFICATION DATE	DELIVERY MODE
01/14/2008	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	10/615,915	YAMAZAWA ET AL.	
	Examiner	Art Unit	
	Rakesh K. Dhingra	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *03* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *24 October 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3,4,6,11,18,19,28-30,41 and 45-55* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3,4,6,11,18,19,28-30,41 and 45-55* is/are rejected.

7)☒ Claim(s) *1* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *7/10/03* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 10/24/07 has been entered.

Claim Objections

Claim 1 is objected to because of the following informalities:

Line 28 of the claim recites in part "and configured off the fundamental frequency of the RF power" which should instead read as "and configured to cut off the fundamental frequency of the RF power".

Appropriate correction is required.

Response to Arguments

Applicant's arguments with respect to independent claims 1, 3, 4, 6, 1-16, 18, 19, 26-30 and 41-44 have been considered but are moot in view of the new ground(s) of rejection as explained hereunder.

Applicant has amended claims 1, 45 by adding new limitation "amplify by a resonant action".

Claims 1, 3, 4, 6, 11, 18, 19, 28-30, 41 and 45-55 are now pending in the present application and are active.

New references [Annaratone et al (US 5,849,372), and Ohmi (US 5,272,417)] when combined with Roux et al read on amended claims 1, 45 limitations.

Accordingly independent claims 1, 45 and dependent claims 3, 4, 11, 28-30, 41 and 47-53 have been rejected under 35 USC 103 (a) as explained below. Further balance dependent claims 6, 18, 19, 46, 54 and 55 have also been rejected under 35 USC 103 (a) as explained below.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 3, 4, 11, 28-30, 41, 45, 47-53 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raoux et al (US Patent No. 7,004,107) in view of Annaratone et al (US 5,849,372) and Ohmi (US 5,272,417).

Regarding Claims 1, 41, 45, 51-53: Raoux et al teach a plasma apparatus (Figures 1, 5, 7, 11) that includes:

an airtight process chamber 30 that accommodates a wafer 36;

a gas supply system 89 and an exhaust system 88;

first and second electrodes 40, 32;

high & low frequency power sources 12, 17, high frequency matching unit 13, a processor 85 and an impedance tuner 108 (impedance setting section), and an impedance probe 110 connected through a first interconnection to an electrode 22 to be electrically coupled to plasma. Roux et al further teach that the impedance probe 110 connected both to upper electrode side and to the lower electrode and the impedance setting section 108 are also in communication with the processor 85, and based upon input from the impedance probe 110, processor 85 can adjust impedance setting of the impedance tuner 108. Raoux et al also teach that the impedance setting section (impedance tuner 108) with impedance probe 110 and the processor 85 can be configured to set a previously defined value of plasma impedance (resonance target). Roux et al additionally teach that impedance tuner 108 (impedance setting section) can comprise a variable capacitor (Figure 11) or even a parallel LC circuit. Roux et al additionally teach that by controlling the capacitance of capacitor 20, resonance of higher harmonics can be controlled to tune the nature and concentration of the reactive species in the plasma. Though Roux et al do not explicitly teach a matching network connected in the RF supply line to the lower electrode, use of same is known in the art as per reference cited below (Ohmi) to enable match the plasma impedance with the RF generator impedance for reducing RF power reflections {column 6, lines 10-25 and column 8, line 62 to column 9, line 40 and column 10, lines 45-65 and column 18, lines 12-62}.

Roux et al do not explicitly teach that the impedance setting section is configured to amplify by a resonance action a higher harmonic of a fundamental frequency of the RF power, which is input from the plasma into the first interconnection, and thereby set an impedance relative to the higher harmonic, the

impendence setting section being capable of changing a higher harmonic to be treated as a resonance target; and further that the impedance setting section comprises an impedance change unit connected to the first interconnection through a shunt and configured to select a higher harmonic as a resonance target, and a filter disposed on the shunt between the first interconnection and the impedance change unit and configured to and to cut a off the fundamental frequency of the RF power.

Annaratone et al teach a plasma apparatus comprising:

A plasma chamber with electrodes 1 and 2, an RF source 9 and a variable frequency power source 11 such that the plasma in the reactor can be tuned to resonance at higher harmonics of the fundamental frequency. Anaratone et al also teach that the resonance at higher harmonics frequencies generates a standing wave effect in the plasma so that the RF power can be coupled more efficiently to the plasma (for example, Fig. 1-3 and col. 2, line 40 to col. 6, line 25). It would be obvious to configure the controller in Roux et al apparatus so as to supply a control signal to the impedance setting unit to enable resonance at harmonics frequencies, which generates a standing wave effect in the plasma and the RF power can be coupled more efficiently to the plasma.

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to configure the controller in Roux et al apparatus to send signals for generating resonance at higher harmonics of fundamental frequency as taught by Annaratone et al in the Roux et al to enable couple more efficiently to the plasma.

Roux et al in view of Annaratone et al teach an impedance setting unit on the first interconnection through a shunt, and also teach that by generating resonance at higher harmonics of the fundamental frequency, power can be coupled more efficiently to plasma by supplying power at higher harmonics, but do not teach the impedance setting unit can supply RF power at higher harmonics by resonance action, and that the impedance setting unit comprises an impedance change unit and a filter connected in series

and disposed on a shunt between the first or second electrodes and the matching circuit on the first interconnection.

Ohmi teaches a plasma apparatus comprising a process chamber 105 in which a lower electrode 104 that supports a substrate 103 to be processed, is connected to an RF supply 110 through a matching circuit 108 and an upper electrode 107 connected to a second RF source 111 through a second matching circuit 109. Ohmi further teaches an impedance setting device 401 comprising a filter 402 disposed on a shunt between the lower electrode 104 and the matching circuit 108 on the first interconnection, and a resonance unit (impedance change unit) 403. Ohmi also teaches that the filter 402 and the impedance change unit 403 can be configured to supply power by resonance action to the electrode 104 at desired selected frequencies (that is configured to cut-off the fundamental frequency and resonate at higher harmonics of the fundamental frequency of RF power). Ohmi additionally teaches that the frequencies selected for resonance can also be related to higher harmonics due to non-linear nature of plasma (for example, Fig. 4b and col. 12, line 35 to col. 13 line 25). It would be obvious to configure the filter 402 and the impedance setting unit 403 for resonance at the higher frequencies of a fundamental frequency of RF power, in view of teaching of Ohmi and Annaratone et al to enable couple power more efficiently with the plasma.

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to provide an impedance setting unit comprising an impedance change unit and a filter disposed on a shunt between between the matching circuit and the electrode, and configured so as to cut-off the fundamental frequency and resonate at higher harmonics of the fundamental frequency of RF power, as taught by Ohmi in the apparatus of Roux et al in view of Annaratone et al to provide resonance at the selected frequency to provide improved coupling of RF power to the plasma.

Regarding Claims 3, 4: Raoux et al teach that in the apparatus preset control profiles for each process can be stored in the software program in advance which result in improved uniformity and

stability of the plasma process on the target substrate (col. 9, lines 40-55 and col. 21, line 60 to col. 22, line 15).

Regarding Claims 11, 47: Rouax et al in view of Annaratone et al and Ohmi teach the value of the impedance set by the impedance setting unit (including impedance against the RF power) can be set (configured) and controlled as per process limitation, that is the impedance against RF power acts like a result effective variable, to obtain improved processing parameters like etching rate improvement (col. 18, lines 30-65).

Further it has been held in courts as follows:

It would have been obvious to one having ordinary skill in the art to have determined the optimum value of a cause effective variable such as through routine experimentation in the absence of a showing of criticality. *In re Woodruff*, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Regarding Claims 28-30, 48-50: Roux et al teach a second RF power supply 12 connected to upper electrode 40 at second interconnection and where the frequency of first RF source 17 (350-950 KHz) is lower than frequency of second RF generator 12 (13.56 MHz). Further, relative values of frequencies supplied by first and second RF sources are also dependent upon the type of process, apparatus configuration and other process limitations.

Claims 6, 46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raoux et al (US Patent No. 7,004,107) in view of in view of Annaratone et al (US 5,849,372) and and Ohmi (US 5,272,417) as applied to Claims 1, 3, 4, 11, 28-30, 41, 45, 47-53 and further in view of Collins et al (US Patent No. 6,252,354).

Regarding Claims 6, 46: Raoux et al in view of Annaratone et al and Ohmi teach all limitations of the claim including that variable capacitor of the impedance tuner 108 (Raoux et al) enables impedance to

be automatically adjusted (continuously varying element) in response from the impedance probe 110 to enable control impedance.

Rouax et al in view of Annaratone et al and Ohmi do not teach impedance control stepwise by switching a plurality of fixed elements.

Collins et al teach an apparatus (Figures 5, 6) that uses plurality of switches 520, 520' which can be closed in different combinations to provide choice of resistive matching ranges to facilitate impedance matching and that various inductive and capacitive elements may be fixed or variable (Column 10, line 52 to Column 11, line 37).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use stepwise control of impedance as taught by Collins et al in the apparatus of Raoux et al in view of Annaratone et al and Ohmi to provide optimization of plasma parameters.

Claims 18, 19, 54, 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raoux et al (US Patent No. 7,004,107) in view of Annaratone et al (US 5,849,372) and Ohmi (US 5,272,417) as applied to Claims 1, 3, 4, 11, 28-30, 41, 45, 47-53 and further in view of Hilliker (US Patent No. 6,631,693).

Regarding Claims 18, 54: Raoux et al in view of Annaratone et al and Ohmi teach all limitations of the claim including that filter 312 is configured to pass energy at a fundamental frequency and block other frequencies.

Rouax et al in view of Annaratone et al and Ohmi do not teach filter has a high impedance of not less than 50 ohm against harmonics other than a selected harmonic.

Hilliker teaches a plasma apparatus (Figures 2, 6) wherein a reactor 104 is connected with a filter network 102, through a matching network 103. Hilliker further teaches that filter network 102 isolates RF generator 101 from the plasma load and also stabilizes the voltage waveform seen by the plasma in the

reactor. Hilliker also teaches that the filter circuit comprises parallel resonant circuit and can allow frequencies of interest (includes higher harmonics as) to be delivered to plasma and absorb the unwanted frequencies (including fundamental frequency of RF power). Hilliker additionally teach that location of filter circuit 202 can be varied with respect to impedance matching elements 111 depending upon the type of applications. Hilliker further teaches that filter 102 (Figures 1) have a resistance of 50 ohm to enable dissipate energy at other than desired frequencies (Column 4, lines 26-53).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use filter circuit with a high resistance of 50 ohm as taught by Hilliker in the apparatus of Raoux et al in view of Annaratone et al and Ohmi to isolate the RF generator from energy of unwanted frequencies.

Regarding Claims 19, 55: Hilliker teaches that filter circuit 601 (Figure 6) include a high pass filter 631 and a low pass filter 621 which can be set to cut any desired frequency including fundamental frequency component (col. 8, lines 25-67).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rakesh K. Dhingra whose telephone number is (571)-272-5959. The examiner can normally be reached on 8:30 -6:00 (Monday - Friday).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on (571)-272-1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Rakesh K. Dhingra

Karla Moore
Primary Examiner
Art Unit 1763